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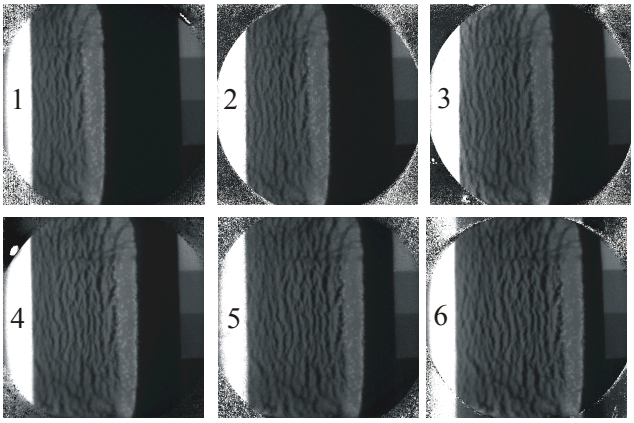
Extending Particle Image Velocimetry Methods To Radiographic Data

Particle Image Velocimetry (PIV) is being successfully applied in the ICF&RP Program to studies of hydrodynamic instabilities and jets. PIV measurements of gas-curtain flows in a shock-tube (in group DX-3) have enabled validation of a simple, inviscid model for gas-curtain growth (Prestridge et al. 2000, *PRL* **84**:4353). We are now using PIV to measure velocity distributions of flows in convergent geometry. Although PIV has been used extensively in fluid dynamics research of incompressible flows, our work with gas-curtain and cylindrical targets is the first application of PIV to shock-accelerated, compressible flows. We are also extending PIV methods to other regimes of interest in inertial fusion research.

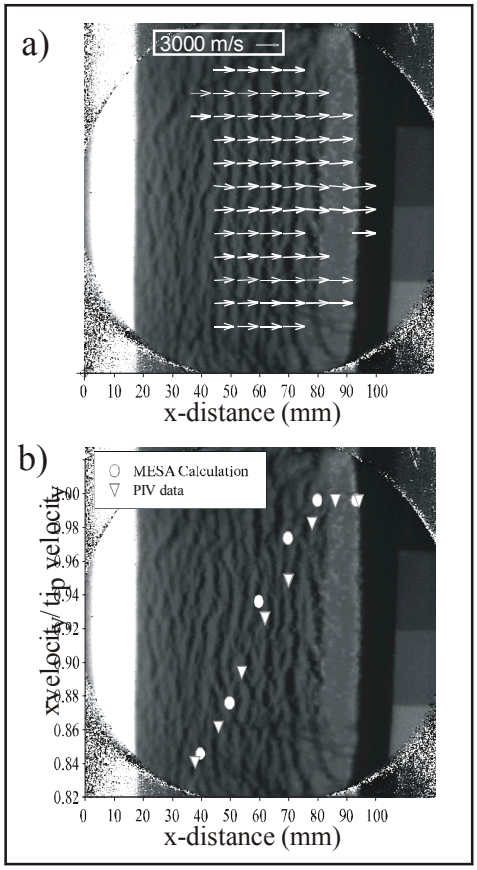
The PIV technique is based on tracking tracer particles in successive images. In practice, PIV is more efficiently done by pattern matching using cross-correlation to determine displacement of small particle clusters or other material patterns. PIV has traditionally been an optically based technique, but we have discovered that it can be used to map velocity fields inferred from radiographic images. We have successfully applied PIV methods to analysis of radiographic data in an explosively-driven silver-liner experiment. This silver-liner experiment was performed at Los Alamos' proton radiography facility, which has the ability to record a time sequence of images of a single event. The numbered images shown below represent a sequence from the silver liner experiment, where the sheet of silver is propagating from left to right in the images, and the time between images is 2.147 ms.



Images 5 and 6 were interrogated using the cross-correlation algorithm which, instead of tracking patterns of particles, tracked the persistent, small-scale features visible in the sheet of silver due to small differences in thickness throughout the sheet.

The results of the cross-correlation between images 5 and 6, above, are shown in the following figure (a), where the velocity field is superimposed on the sixth image. In (b), the velocity vectors at each *x* location have been averaged to give an average velocity at each downstream position (triangles). These results are compared with a 2-D MESA calculation (circles), which was performed before the experiment was shot in order to predict the tip velocity. This demonstrates the successful application of PIV techniques to processing PRAD radiographic data. The next step is the application of these methods to x-ray radiographic information that can be used in turbulence studies.

*For more information contact Kathy Prestridge (*kpp@lanl.gov*)*



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